State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: **ALI ALQATMI, Chief**
Design Branch Z
Office of Design I
Central Region Project Development

Date: December 22, 2009

File: 06-Mad-99
Project Limits: PM 9.5/13.1
EA: 06-0E0401
Equipment No.: JILS-1314

From: **Ted Mooradian, Chief**
DEPARTMENT OF TRANSPORTATION
Central Region Materials Engineering Branch - Fresno

Subject: Flexible Pavement Deflection Study Report

In accordance with your June 1, 2009 request, we have developed pavement rehabilitation alternatives for the existing pavement in the above-referenced rehabilitation project in Madera County on Route 99 from south of the South Madera overcrossing to north of the Avenue 16 overcrossing. Design recommendations are based on the deflection study conducted on November, 2009 by Materials Engineering Branch personnel. In each test section, two cores were taken to determine the existing asphalt concrete (AC) thickness and the type of base material.

Operator's field notes indicate recent Rubberized Hot Mixed Asphalt (Type O) over the pre-existing AC surface at the beginning and end of project approximate 0.10 miles at both end. Rest of the pavement is asphalt concrete. Eleven pavement core samples were drilled at various locations. Average core thickness is 1.17 ft (0.41 ft AC and 0.76 ft PCC). The pavement core sample drilled at PM 13.10 in the northbound direction lane # 2 had AC over aggregate base and core delaminated at 0.61 ft from the top. All other samples indicate that dense graded asphalt concrete is placed on pre-existing PCC pavement. All core samples were sound except one at PM 9.60 in the southbound direction lane # 2, which delaminated at 0.23 ft from the top.

The year *2007 Pavement Condition Survey Inventory* report indicates a maximum International Roughness Index (IRI) of 155 inches/mile from PM 11.7 to PM 11.8 the northbound direction in lane # 2. According to the Caltrans July 1, 2008 Highway Design Manual, the maximum allowable value of IRI that does not require special consideration in design is 170 inches/mile.

Transportation Planning reports that the twenty-year Traffic Index (TI_{20}) is 16.5. The estimated pavement thickness, 80th percentile of the measured deflections, the tolerable deflections, and the base type are summarized in Table 1.

The data were analyzed for structural adequacy, reflective crack retardation and ride quality. In spite of the some structural adequacy, reflective crack retardation governs the overlay thickness in both directions for the entire length of the project.

Table 1: Summary of Data

Location	Lane #	PM/PM	TI_{20}	Base Type	Average AC Thickness ft	Average 80th Percentile Deflection mils	Tolerable Deflection mils	Maximum IRI in/mile
Mad-99 Northbound Lanes	2	9.5/10.0	16.5	PCC	0.41	6	5	149
	2	11.7/13.1		PCC	0.47	6	5	155
Mad-99 Southbound Lanes	2	12.8/13.1		PCC	0.35	6	5	110
	2	11.7/12.8		PCC	0.40	6	5	120
	2	9.5/10.0		PCC	0.44	5	5	130

AC = Dense Graded Asphalt Concrete
OG = Original Ground
PCC = Portland Cement Concrete
IRI = International Roughness Index

Twenty-Year Rehabilitation Recommendations

These recommendations for rehabilitation are based on traffic index, type of base material, thickness of existing pavement, evaluated eightieth percentile deflection, calculated tolerable deflection, and judgment of the design engineer. The design alternatives are controlled by requirement for retardation of reflection cracking.

For Hot Mix Asphalt – Type A (HMA - A) mix, we recommend to use PG 70-10 or PG 64-28PM grade binder and for Rubberized Hot Mix Asphalt – Gap Graded (RHMA-G) mix, we recommend to use PG 64-16 grade binder.

PM 9.5 TO PM 10.0 AND PM 11.7 TO PM 13.1

Alternative 1

Rubberized Hot Mix Asphalt - Gap Graded (RHMA - G) Overlay

- Conduct a field review and locate specific areas of severe distress, such as rutting greater than 0.05' and/or loose or spalling pavement and pumping cracks.
- Repair the localized distressed areas with HMA and, if necessary, AB also. Seal all cracks wider than 0.02'.
- Place 0.10' HMA-A, then place Stress Absorbing Membrane Interlayer (Rubberized) [SAMI-R].
- Place 0.20' RHMA-G overlay.
- This alternative will raise the profile grade by 0.30'.

Alternative 2

Hot Mix Asphalt - Type A (HMA - A) Overlay

- Conduct a field-review and locate specific areas of severe distress as described above.
- Cold plane 0.10' deep so as to remove the existing RAC-O (where ever exist) in order to reduce the potential moisture vapor action and the resultant stripping problem.
- Repair the localized distressed areas and seal cracks as described above.
- Place 0.15' HMA - A (Leveling Course) then place SAMI-R or Stress Absorbing Membrane Interlayer (Fabric) [SAMI-F].
- Place 0.30' HMA – A overlay.
- This alternative will raise the profile grade by 0.45'.

Alternative 3

Cold Plane Existing Pavement and Replace with Rubberized Hot Mix Asphalt - Gap Graded (RHMA-G)

- Conduct a field review and locate specific areas of severe distress as described above.
- Cold Plane the existing pavement to a depth of 0.35'.
- Repair the localized distressed areas that remain and seal any remaining cracks wider than 0.02'.
- Place 0.15' HMA-A then place SAMI-R.
- Place 0.20' RHMA-G overlay.
- This alternative will maintain the existing profile grade.

Alternative 4

Cold Plane Existing Pavement and Replace with Hot Mix Asphalt Type A (HMA - A)

- Conduct a field review and locate specific areas of severe distress as described above.
- Cold Plane the existing asphalt concrete (AC) pavement down to PCC.
- Repair any localized distressed areas in the PCC and seal any remaining cracks wider than 0.02'.
- Place 0.10' HMA-A (Leveling Course) then place SAMI-R or SAMI-F.
- Place 0.50' HMA – A.
- This alternative will raise the profile grade by 0.25'.

Alternative 5

Cold Plane Existing Pavement and Replace with RHMA - G

- Conduct a field review and locate specific areas of severe distress as described above.
- Cold Plane the existing AC pavement down to PCC.
- Repair any localized distressed areas that remain and seal any remaining cracks wider than 0.02'.
- Place 0.10' HMA-A (leveling course) then place SAMI-R or SAMI-F.
- Place 0.15' HMA – A then place 0.20' RHMA – G.
- This alternative will raise the profile grade by 0.10'.

Remarks

Due to high volume of traffic hot or cold recycling is not recommended as an alternate.

The recommended design alternatives should provide twenty years of service with minimum maintenance costs, provided that the design parameters remain valid and Caltrans specifications and standards are implemented during construction.

If you have any questions regarding the above design recommendations, please call Sarabjit Singh at 488-4007 or Bob Voss at 488-4002.

SARABJIT SINGH, P.E.
Central Region Materials Eng. Br.– Fresno

R.W. VOSS, P.E.
Central Region Materials Eng. Br.-Fresno

Chk: RV

Attachments: Yes

cc: BFarnbach
RMarsh
B.Moseg

DISCLAIMER

All preceding analyses and rehabilitation strategies were based on deflection test results obtained in the fields, core data, input parameters obtained from various sources within Caltrans, as well as assumption pertinent to the design methodology adopted for the analysis. Any variations from the value provided could have a significant impact on the results and recommendations presented in this report. This office bears no responsibility for any alterations that are made, for whatever reason, to the preceding design(s), without prior discussion with this office, for that such alterations could to inadequate performance and premature failure of the constructed pavement structural section. Also, while this office makes every effort to precisely follow the available standard methods for testing and design combined with sound engineering judgement, improper construction practices can have a negative impact on the pavement performance irrespective of the accuracy practiced in the engineering analysis for obtaining the proposed rehabilitation strategies.

DYNAFLECT MAP COVER SHEET

EA #	DISTRICT	COUNTY	ROUTE	PROJECT LIMITS	OPERATOR	DATE
0E0401	6	MAD	99	9.5/13.1	SINGH	11/08/09

RANGE OF EVALUATED DEFLECTION	**0.126**	**to**	**0.153 MM**
	0.005	to	0.006 IN
AVERAGE EVALUATED DEFLECTION (AVG OF 80TH PCT)			**0.142 MM**
			0.006 IN
AVERAGE AC CORE THICKNESS			**126 MM**
			0.41 FT
AVERAGE TOTAL CORE THICKNESS			**356 MM**
			1.17 FT
MAXIMUM RIDESCORE			**MM**
			IN

NOTE:

- ALL DEFLECTIONS ARE IN TERMS OF EQUIVALENT DEFLECTOMETER VALUES.
- SHOWN ARE 80TH PERCENTILE DEFLECTIONS (MM) FOR 1000' TEST SECTIONS.
- PAVEMENT DEFLECTIONS MEASURED AT 0.01 MILE INTERVALS.

COMMENTS:

DEFLECTION SUMMARY SHEET

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

EA #	DIST.	COUNTY	ROUTE	PROJECT LIMITS	OPERATOR	DATE
0E0401	6	MAD	99	9.5/13.1	SINGH	11/08/09

TEST# 1 **P.M.** 13.10 TO 11.73 **L #** 2 OF 2 **DIRECT:** NB

SURFACE DGAC **BASE** PCC **WEATHER** clear

CONTROLS? YES , OVERPASS **TEMP** AIR 50 SURFACE 50

DEFLECTION DATA			
AC Th.	TOTAL Th.	MEAN	80TH
0.47 FT	1.18 FT	0.004 IN	0.006 IN
143 MM	360 MM	0.109 MM	0.144 MM

ALLIGATOR = NONE TRANS = CONTINUOUS LONG = CONTINUOUS D/OUT = NONE
D/HOLES = INTERMITTENT PUMP = NONE CORRU = NONE BLEED = NONE
PATCH = NONE RUTTING = NONE RAVEL = NONE

COMMENTS : THREE CORES WERE TAKEN IN THIS TEST SECTION. FIRST CORE WAS DELAMINATED @ 0.61', AC THICKNESS WAS 1.35', TOTAL CORE THICKNESS WAS 1.35' AND BASE MATERIAL WAS AGG. BASE.
SECOND CORE WAS INTACT, AC THICKNESS WAS 0.34', TOTAL CORE THICKNESS WAS 1.05' AND BASE MATERIAL WAS PCC.

TEST# 2 **P.M.** 10.00 TO 9.50 **L #** 2 OF 2 **DIRECT:** NB

SURFACE DGAC **BASE** PCC **WEATHER** clear

CONTROLS? YES , OVERPASS **TEMP** AIR 56 SURFACE 64

DEFLECTION DATA			
AC Th.	TOTAL Th.	MEAN	80TH
0.41 FT	1.20 FT	0.004 IN	0.006 IN
125 MM	366 MM	0.106 MM	0.141 MM

ALLIGATOR = NC TRANS = NC LONG = NC D/OUT = NC
D/HOLES = NONE PUMP = NONE CORRU = NONE BLEED = NONE
PATCH = NONE RUTTING = NONE RAVEL = NONE

COMMENTS : TWO CORES WERE TAKEN IN THIS TEST SECTION.
FIRST CORE WAS INTACT, AC THICKNESS WAS 0.32', TOTAL CORE THICKNESS WAS 1.00', BASE MATERIAL WAS PCC, AND BASE THICKNESS WAS 0.68'.

TEST# 3 **P.M.** 11.73 TO 12.80 **L #** 2 OF 2 **DIRECT:** SB

SURFACE DGAC **BASE** PCC **WEATHER** clear

CONTROLS? YES , OVERPASS **TEMP** AIR 60 SURFACE 46

DEFLECTION DATA			
AC Th.	TOTAL Th.	MEAN	80TH
0.35 FT	1.03 FT	0.004 IN	0.006 IN
107 MM	314 MM	0.108 MM	0.147 MM

ALLIGATOR = NONE TRANS = CONTINUOUS LONG = CONTINUOUS D/OUT = NONE
D/HOLES = NC PUMP = NONE CORRU = NONE BLEED = NONE
PATCH = NONE RUTTING = NONE RAVEL = NONE

COMMENTS : TWO CORES WERE TAKEN IN THIS TEST SECTION.
FIRST CORE WAS INTACT, AC THICKNESS WAS 0.36', TOTAL CORE THICKNESS WAS 1.06', BASE MATERIAL WAS PCC, AND BASE THICKNESS WAS 0.70'.

TEST# 4 **P.M.** 12.80 TO 13.10 **L #** 2 OF 2 **DIRECT:** SB

SURFACE DGAC **BASE** PCC **WEATHER** clear

CONTROLS? YES , OVERPASS **TEMP** AIR 56 SURFACE 61

DEFLECTION DATA			
AC Th.	TOTAL Th.	MEAN	80TH
0.40 FT	1.33 FT	0.005 IN	0.006 IN
122 MM	405 MM	0.116 MM	0.153 MM

ALLIGATOR = NONE TRANS = NC LONG = NC D/OUT = OCCASIONAL
D/HOLES = INTERMITTENT PUMP = NONE CORRU = NONE BLEED = NONE
PATCH = NONE RUTTING = NONE RAVEL = NONE

COMMENTS : TWO CORES WERE TAKEN IN THIS TEST SECTION.
FIRST CORE WAS INTACT, AC THICKNESS WAS 0.30', TOTAL CORE THICKNESS WAS 1.45', BASE MATERIAL WAS PCC, AND BASE THICKNESS WAS 1.15'.

TEST# 5 **P.M.** 9.50 TO 10.00 **L #** 2 OF 2 **DIRECT:** SB

SURFACE DGAC **BASE** PCC **WEATHER** misty

CONTROLS? YES , OVERPASS **TEMP** AIR 41 SURFACE 36

DEFLECTION DATA			
AC Th.	TOTAL Th.	MEAN	80TH
0.44 FT	1.10 FT	0.004 IN	0.005 IN
134 MM	335 MM	0.094 MM	0.126 MM

ALLIGATOR = INTERMITTENT TRANS = NC LONG = NC D/OUT = NC
D/HOLES = NONE PUMP = NONE CORRU = NONE BLEED = NONE
PATCH = NONE RUTTING = NONE RAVEL = NONE

COMMENTS : TWO CORES WERE TAKEN IN THIS TEST SECTION.
FIRST CORE WAS DELAMINATED @ 0.23', AC THICKNESS WAS 0.51', TOTAL CORE THICKNESS WAS 1.17', BASE MATERIAL WAS PCC, AND BASE THICKNESS WAS 0.66'.

STATE OF CALIFORNIA, DEPARTMENT OF TRANSPORTATION — Sheet __ of __

Division of Engineering Services

Materials Engineering and Testing Services

District-County Route-PM/PM: 06-MAD-99-9.50/13.10

Expense Authorization (EA): 0E0401

LOG OF MAINLINE CORE HOLES

DeflcTrack Number:

Core Rig Operator: WALLS — Date of Coring: 11/8,15,22/2009 — No. of Cores: 11

Deflection Test Operator: SINGH — Date of Deflection Test: 11/8,15,22/2009

Test Section	Core Hole Location (PM, Lane No., Direction)	Layer 1 (Seal Coat?)	Layer 2 (Struct. Sect.)	Layer 3 (Struct. Sect.)	Layer 4 (Struct. Sect.)	Layer 5 (Base Matrl)	Total Core Thickness	Remarks
1	PM 13.10, LANE 2 OF 2, NB 99		1.35 DGAC			AB	1.35 DGAC	CORE DELAM @ 0.61' FROM TOP.
1	PM 12.40, LANE 2 OF 2, NB 99		0.34 DGAC			0.71 PCC	1.05	INTACT
1	PM 11.77, LANE 2 OF 2, NB 99		0.60 DGAC			0.70 PCC	1.3	INTACT
2	PM 9.93, LANE 2 OF 2, NB 99		0.32 DGAC			0.68 PCC	1	INTACT
2	PM 9.58, LANE 2 OF 2, NB 99		0.49 DGAC			0.55 PCC	1.04	INTACT
3	PM 12.03, LANE 2 OF 2, SB 99		0.36 DGAC			0.70 PCC	1.06	INTACT
3	PM 12.47, LANE 2 OF 2, SB 99		0.33 DGAC			0.66 PCC	0.99	INTACT
4	PM 12.89, LANE 2 OF 2, SB 99		0.30 DGAC			1.15 PCC	1.45	INTACT
4	PM 13.10, LANE 2 OF 2, SB 99		0.49 DGAC			0.71 PCC	1.2	INTACT
5	PM 9.60, LANE 2 OF 2, SB 99		0.51 DGAC			0.66 PCC	1.17	CORE DELAM @ 0.23' FROM TOP.
5	PM 9.95, LANE 2 OF 2, SB 99		0.36 DGAC			0.66 PCC	1.02	INTACT

Core Log Prepared By: STEPHEN WALLS 11/30/2009

(Name and Date)

AXR082
01/07/03

TRAFFIC ACCIDENT SURVEILLANCE AND ANALYSIS SYSTEM
CURRENT HIGHWAY SEQUENCE LISTING (W/ CITIES)
DIST 06 RTE 099 DIR S-N

CO.	CITY	POSTMILE	G RF PT	LENGTH	DESCRIPTION	SEQ.	EFF. DATE
MAD		009.372	DR		SB ON FROM GATEWAY DR	0051835	640101
MAD		009.490	DH	00.071	GATEWAY DRIVE	0051900	640101
MAD		009.560	DR		NB OFF TO GATEWAY DR	0051911	640101
MAD		009.561	DH	00.072		0052000	640101
MAD		009.633	DH	00.028		0052100	640101
MAD		009.661	DH	00.082		0052200	640101
MAD		009.743	DH	00.445	SOUTH MADERA OC 41 46	0052300	640101
MAD		010.092	DR		NB OFF TO RTE 145	0052380	640101
MAD		010.106	DR		SB ON FR RTE 145	0052391	640101
MAD	MAD	010.188	DH	00.080		0052400	640101
MAD	MAD	010.268	DH	00.493	JCT145. 145/99SEP 41-47	0052599	640101
MAD	MAD	010.410	DR		NB ON FR RTE 145	0052615	640101
MAD	MAD	010.462	DR		SB OFF TO RTE 145	0052620	640101
MAD	MAD	010.761	DH	00.083	W SIXTH ST OC 41 48	0052900	640101
MAD	MAD	010.844	DH	00.165	WEST YOSEMITE AVE OC	0053000	640101
MAD	MAD	010.883	DR		SB ON FROM 4TH ST	0053005	640101
MAD	MAD	010.918	DR		NB OFF TO 4TH ST	0053010	640101
MAD	MAD	011.009	DH	00.082	WEST FOURTH ST OC 41-50	0053300	640101
MAD	MAD	011.091	DH	00.089	MADERA UNDERPASS 41 51	0053400	640101
MAD	MAD	011.180	DH	00.220	SECOND ST	0053600	640101
MAD	MAD	011.258	DR		SB OFF TO 2ND ST	0053610	640101
MAD	MAD	011.269	DR		NB ON FROM 2ND ST	0053620	640101
MAD	MAD	011.400	DH	00.246		0053650	640101
MAD	MAD	011.646	DH	00.080	FRESNO RIVER 41-52	0053700	640101
MAD	MAD	011.726	DH	00.227	END BR 41-52	0053800	640101
MAD	MAD	011.942	DR		NB OFF TO AVE 15 1/2	0053971	640101
MAD	MAD	011.953	DH	00.172		0053975	640101
MAD	MAD	012.001	DR		SB ON FROM AVE 15 1/2	0053990	640101
MAD	MAD	012.125	DH	00.170	CLEVELAND AVE OC 41-53	0054000	640101
MAD	MAD	012.242	DR		NB ON FROM AVE 15 1/2	0054010	640101
MAD	MAD	012.295	DH	00.457		0054100	640101
MAD	MAD	012.304	DR		SB OFF TO AVE 15 1/2	0054125	640101
MAD	MAD	012.722	DR		NB OFF TO AVE 16	0054291	640101
MAD	MAD	012.752	DH	00.008	AVENUE 16 OC 41 58	0054300	640101
MAD	MAD	012.760	DH	00.051		0054302	640101
MAD		012.811	DH	00.227		0054306	640101
MAD		012.815	DR		SB ON FROM AVE 16	0054310	640101
MAD		012.924	DR		NB ON FR AVE 16	0054320	640101
MAD		012.986	DR		SB OFF TO AVE 16	0054330	640101
MAD		013.038	DH	00.073		0054400	640101
MAD		013.111	DH	00.417		0054500	640101